

What is claimed is:

1. A composition for composite sheet, comprising a magnetic fibrous filler (A) and a binder (B), said binder (B) comprising a photocuring component and a 5 thermosetting component.
2. A composite sheet of given thickness in semi-cured form, comprising a semi-cured binder (B1) and, incorporated therein, a magnetic fibrous filler (A), said semi-cured binder (B1) comprising a 10 thermosetting component and a component resulting from curing of a photocuring component, said magnetic fibrous filler (A) orientated in the direction of the thickness of the semi-cured composite sheet.
- 15 3. The composite sheet as claimed in claim 2, wherein the photocuring component is a (meth)acrylic compound.
4. The composite sheet as claimed in claim 2 or 3, wherein the thermosetting component is an epoxy 20 compound.
5. The composite sheet as claimed in any of claims 2 to 4, wherein the magnetic fibrous filler (A) is a fibrous filler having both conductivity and magnetism.

6. The composite sheet as claimed in claim 5, wherein the fibrous filler having both conductivity and magnetism is constituted of a magnetic fibrous filler having a noble metal adhering thereto on its surface.

5 7. The composite sheet as claimed in claim 5, wherein the fibrous filler having both conductivity and magnetism is constituted of at least one member selected from the group consisting of a metallic fiber having magnetism, a fiber having magnetic 10 susceptibilities in a direction of fiber axis and in a direction of fiber circumference which are different from each other and a fiber having a magnetic substance adhering thereto on its surface.

8. The composite sheet as claimed in claim 7, 15 wherein the fiber having magnetic susceptibilities in a direction of fiber axis and in a direction of fiber circumference which are different from each other is a carbon fiber.

9. The composite sheet as claimed in any of 20 claims 2 to 8, wherein the magnetic fibrous filler (A) is constituted of a fiber having a magnetic substance adhering thereto on its surface.

10. The composite sheet as claimed in any of claims 2 to 9, which is an anisotropic conductive sheet.

11. A composite sheet of given thickness in cured form, comprising a binder (B2) and, incorporated therein, a magnetic fibrous filler (A),

5 said binder (B2) comprising a component resulting from curing of a thermosetting component and a component resulting from curing of a photocuring component,

said magnetic fibrous filler (A) orientated in the direction of the thickness of the cured composite sheet.

10 12. A process for producing a composite sheet in semi-cured form, comprising the steps of:

sheeting a composition for composite sheet into a sheet of given thickness, said composition comprising a magnetic fibrous filler (A) and a binder (B), said 15 binder (B) comprising a photocuring component and a thermosetting component, and

not only applying a magnetic field to the composition sheet in the direction of the thickness of the composition sheet so as to orientate the magnetic 20 fibrous filler (A) in the direction of the thickness of the composition sheet but also curing the photocuring component of the sheeted composition, thereby obtaining a semi-cured composite sheet.

13. A method of using a composite sheet, said 25 composite sheet being one of given thickness in semi-

cured form comprising a semi-cured binder (B1) and, incorporated therein, a magnetic fibrous filler (A), said semi-cured binder (B1) comprising a thermosetting component and a component resulting from curing of a 5 photocuring component, said magnetic fibrous filler (A) orientated in the direction of the thickness of the semi-cured composite sheet,

which method comprises the steps of:

interposing the semi-cured composite sheet between 10 an electrode part of a semiconductor element or semiconductor package and a wiring part of a circuit substrate, and curing the thermosetting component of the semi-cured composite sheet to thereby convert the semi-cured 15 composite sheet to a cured composite sheet so that the electrode part and the wiring part are electrically connected to each other.

14. A contact structure comprising an electrode part of a semiconductor element or semiconductor 20 package and a wiring part of a circuit substrate and, interposed therebetween so as to electrically connect them to each other, a composite sheet, said composite sheet being one of given thickness in cured form comprising a binder (B2) and, incorporated therein, a 25 magnetic fibrous filler (A), said binder (B2)

comprising a component resulting from curing of a thermosetting component and a component resulting from curing of a photocuring component, said magnetic fibrous filler (A) orientated in the direction of the
5 thickness of the cured composite sheet.

15. A composite sheet of given thickness comprising a binder and a magnetic fibrous filler (A), said magnetic fibrous filler (A) orientated in the binder in the direction of the thickness of the
10 composite sheet, said orientated magnetic fibrous filler (A) forming a plurality of bundles.

16. The composite sheet as claimed in claim 15, wherein the bundles of the magnetic fibrous filler (A) orientated in the direction of the thickness of the
15 composite sheet are arranged in striped form in a direction of sheet surface.

17. The composite sheet as claimed in claim 15, wherein the bundles of the magnetic fibrous fillers (A) orientated in the direction of the thickness of the
20 composite sheet are arranged in islanded form in a direction of sheet surface.

18. A process for producing a composite sheet, comprising the steps of:
interposing a sheeted composition of given
25 thickness comprising a magnetic fibrous filler (A) and

a thermosetting and/or photocuring binder (B) between a pair of magnetic pole plates each having on its surface projected magnetic pole surface portions, and

not only applying a magnetic field parallel to the

- 5 direction of the thickness of the sheet to the sheeted composition so that the magnetic fibrous fillers (A), while being orientated in the direction of the thickness of the sheet, are bundled in the vicinity of projected magnetic pole surface portions of the
- 10 magnetic pole plates but also curing the binder (B) by heating and/or light irradiation.

19. The process as claimed in claim 18, wherein the magnetic fibrous filler (A) is a conductive filler having a noble metal adhering thereto on its surface.

- 15 20. The process as claimed in claim 18, wherein the magnetic fibrous filler (A) has a thermal conductivity of $100 \text{ W} \cdot \text{m}^{-1} \cdot \text{K}^{-1}$ or greater in a direction of fiber length.

21. The process as claimed in any of claims 18 to 20, wherein the magnetic fibrous filler (A) is constituted of at least one member selected from the group consisting of a metallic fiber having magnetism, a fiber having magnetic susceptibilities in a direction of fiber axis and in a direction of fiber circumference

which are different from each other and a fiber having a magnetic substance adhering thereto on its surface.

22. The process as claimed in claim 21, wherein the fiber having magnetic susceptibilities in a
5 direction of fiber axis and in a direction of fiber circumference which are different from each other is a carbon fiber.

23. The process as claimed in any of claims 18 to 22, wherein the magnetic fibrous filler (A) is
10 constituted of a fiber having a magnetic substance adhering thereto on its surface.

24. The process as claimed in any of claims 18 to 23, wherein the projections of the magnetic pole plates each having on its surface projected magnetic
15 pole surface portions are a plurality of projections arranged in the form of stripes parallel to each other or projections arranged in the form of islands with given spacings.

25. The process as claimed in any of claims 18
20 to 24, wherein the magnetic pole plates each having on its surface projected magnetic pole surface portions have concave portions filled with a nonmagnetic material so that the surfaces of the magnetic pole plates are planar.

26. The process as claimed in any of claims 18 to 25, wherein the magnetic pole plates each having on its surface projected magnetic pole surface portions have concave portions filled with a nonmagnetic material so that the surfaces of the magnetic pole plates are planar, and wherein projections of given configuration constituted of a nonmagnetic material are anchored or adhered onto the magnetic pole plate surfaces.

5 27. A composite sheet of given thickness comprising a binder and a magnetic fibrous filler (A), said magnetic fibrous filler (A) orientated in the binder in the direction of the thickness of the composite sheet, said composite sheet having projections on at least one side thereof.

10 28. The composite sheet as claimed in claim 27, wherein the projections on at least one side of the composite sheet are arranged in striped form in a direction of sheet surface.

15 29. The composite sheet as claimed in claim 27, wherein the projections on at least one side of the composite sheet are arranged in islanded form in a direction of sheet surface.

20 30. A process for producing a composite sheet, comprising the steps of:

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bringing at least one side of a sheeted composition of given thickness comprising a magnetic fibrous filler (A) and a thermosetting and/or photocuring binder (B) into contact with a surface of 5 nonmagnetic substance having a plurality of concaves, and

not only applying a magnetic field parallel to the direction of the thickness of the sheet to the sheeted composition so that the magnetic fibrous filler (A) is 10 orientated in the direction of the thickness of the sheet but also curing the binder (B) by heating and/or light irradiation to thereby obtain a composite sheet having a plurality of projections on at least one side thereof.

15 31. The process as claimed in claim 30, wherein the magnetic fibrous filler (A) is a conductive filler having a noble metal adhering thereto on its surface.

32. The process as claimed in claim 30, wherein the magnetic fibrous filler (A) has a thermal 20 conductivity of $100 \text{ W} \cdot \text{m}^{-1} \cdot \text{K}^{-1}$ or greater in a direction of fiber length.

33. The process as claimed in any of claims 30 to 32, wherein the magnetic fibrous filler (A) is 25 constituted of at least one member selected from the group consisting of a metallic fiber having magnetism,

a fiber having magnetic susceptibilities in a direction of fiber axis and in a direction of fiber circumference which are different from each other and a fiber having a magnetic substance adhering thereto on its surface.

5 34. The process as claimed in claim 33, wherein the fiber having magnetic susceptibilities in a direction of fiber axis and in a direction of fiber circumference which are different from each other is a carbon fiber.

10 35. The process as claimed in any of claims 30 to 34, wherein the magnetic fibrous filler (A) is constituted of a fiber having a magnetic substance adhering thereto on its surface.

15 36. The process as claimed in any of claims 30 to 35, wherein the concaves of the surface of nonmagnetic substance having a plurality of concaves are arranged in the form of stripes parallel to each other or arranged in the form of islands with given spacings.

20 37. The process as claimed in claim 31, wherein the composite sheet is an anisotropic electricity-conductive sheet.

25 38. The process as claimed in claim 32, wherein the composite sheet is an anisotropic heat-conductive sheet.

39. A composite sheet of given thickness comprising a magnetic fibrous filler (A), a binder cured by heating and/or light irradiation, and organic fine particles or inorganic fine particles (C), said 5 magnetic fibrous filler (A) orientated in the direction of the thickness of the composite sheet.

40. The composite sheet as claimed in claim 39, wherein the magnetic fibrous filler (A) is constituted of at least one member selected from the group 10 consisting of a metallic fiber having magnetism, a fiber having magnetic susceptibilities in a direction of fiber axis and in a direction of fiber circumference which are different from each other and a fiber having a magnetic substance adhering thereto on its surface.

15 41. The composite sheet as claimed in claim 39 or 40, wherein the magnetic fibrous filler (A) is a conductive filler having a noble metal adhering thereto on its surface and wherein the organic fine particles or inorganic fine particles (C) are insulators.

20 42. The composite sheet as claimed in claim 41, wherein the organic fine particles or inorganic fine particles (C) constitute insulating fine particles having an average diameter of 1 to 100 μ m.

43. The composite sheet as claimed in claim 41 25 or 42, wherein the organic fine particles or inorganic

fine particles (C) constitute insulating fine particles whose volume ratio in the composite sheet is in the range of 2 to 50%.

44. The composite sheet as claimed in any of

5. claims 39 to 43, wherein the magnetic fibrous filler (A) has a thermal conductivity of $100 \text{ W} \cdot \text{m}^{-1} \cdot \text{K}^{-1}$ or greater in a direction of fiber length and wherein the organic fine particles or inorganic fine particles (C) also have a thermal conductivity of $100 \text{ W} \cdot \text{m}^{-1} \cdot \text{K}^{-1}$ or

10 greater.

45. The composite sheet as claimed in any of claims 41 to 43, which is a sheet having anisotropic electric conductivity.

46. The composite sheet as claimed in claim 44,

15 which is a sheet having anisotropic thermal conductivity and anisotropic electric conductivity.

47. A process for producing a composite sheet, comprising the steps of:

sheeting a composition into a sheet of given

20 thickness, said composition comprising a magnetic fibrous filler (A), a thermosetting and/or photocuring binder (B), and organic fine particles or inorganic fine particles (C), and

not only applying a magnetic field to the

25 composition sheet in the direction of the thickness of

the composition sheet so as to orientate the magnetic fibrous filler (A) in the direction of the thickness of the composition sheet but also curing the binder (B) by heating and/or light irradiation.

5 48. A composite sheet of given thickness to be interposed between a semiconductor element and a circuit substrate, comprising a magnetic fibrous filler (A) orientated in the direction of the thickness of the composite sheet, at least 80% of the magnetic fibrous 10 filler (A) having a fiber length L_1 satisfying the relationship:

$$0.5 \times D < L_1 < (L_2^2 + D^2)^{1/2} \quad (I)$$

wherein L_1 represents a fiber length of magnetic fibrous filler (A), D represents a thickness of 15 composite sheet, and L_2 represents a minimum distance between neighboring electrodes among neighboring-electrode distances with respect to electrodes arranged on a semiconductor element on its composite sheet side or neighboring-electrode distances with respect to 20 electrodes arranged on a circuit substrate on its composite sheet side.

49. The composite sheet as claimed in claim 48, wherein the magnetic fibrous filler (A) is a fibrous filler having both conductivity and magnetism.

50. The composite sheet as claimed in claim 49,
produced by a process comprising the steps of:

sheeting a composition into a sheet of given
thickness, said composition comprising a fibrous filler

5 having both conductivity and magnetism and a
thermosetting and/or photocuring binder (B), and

not only applying a magnetic field to the
composition sheet in the direction of the thickness of
the composition sheet so as to orientate the fibrous

10 filler having both conductivity and magnetism in the
direction of the thickness of the composition sheet but
also curing the binder (B) by heating and/or light
irradiation.

51. The composite sheet as claimed in claim 49
15 or 50, wherein the fibrous filler having both
conductivity and magnetism is constituted of a magnetic
fibrous filler having a noble metal adhering thereto on
its surface.

52. The composite sheet as claimed in any of
20 claims 49 to 51, wherein the fibrous filler having both
conductivity and magnetism is constituted of at least
one member selected from the group consisting of a
metallic fiber having magnetism, a fiber having
magnetic susceptibilities in a direction of fiber axis
25 and in a direction of fiber circumference which are

different from each other and a fiber having a magnetic substance adhering thereto on its surface.

53. The composite sheet as claimed in claim 52, wherein the fiber having magnetic susceptibilities in a 5 direction of fiber axis and in a direction of fiber circumference which are different from each other is a carbon fiber.

54. The composite sheet as claimed in any of claims 49 to 53, wherein the fibrous filler having both 10 conductivity and magnetism (A1) is constituted of a fiber having a magnetic substance adhering thereto on its surface.

55. The composite sheet as claimed in any of claims 49 to 54, which is an anisotropic conductive 15 sheet.

56. A method of using a composite sheet, comprising electrically connecting an electrode of a semiconductor element and an electrode of a circuit substrate to each other through each of the composite 20 sheets of claims 49 to 55.